Resistance of *Lycopersicon* Species to the Carmine Spider Mite

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Resistance of *Lycopersicon* Species to the Carmine Spider Mite

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The carmine spider mite (*Tetranychus cinnabarinus* (Boisduval)) [1] often seriously damages commercial tomato (*Lycopersicon esculentum*) crops in certain areas of the United States. Its destruction becomes especially serious during hot, dry seasons, which favor rapid reproduction of this pest. Although mites can be controlled with acaricides, host resistance is a more desirable control measure. Stoner and Stringfellow [2] and Gilbert and others [3] found a considerable difference in the susceptibility of commercial tomato varieties to the carmine mite. Wolfenbarger [4] reported on the varied susceptibility of *Lycopersicon* species, varieties, interspecific crosses, and genetic markers to the mite *T. marianae* McGregor.

To evaluate further the levels of resistance in the genus *Lycopersicon* to the carmine spider mite, 220 Plant Introduction (P.I.) lines or accessions were screened. The results of the evaluation are presented in this report.

MATERIALS AND METHODS

The screening technique used was similar to that reported by Stoner and Stringfellow.[2] Five plants of each line or accession to be evaluated were grown in 4-inch clay pots until they were 6 to 8 weeks old. The artificial soil mixture described by Boodley and Sheldrake [5] was used to assure uniform soil fertility. The plants were grown in a greenhouse during the winter of 1966–67, when the average daylength was 10 to 11 hours. The temperature was kept at 85° F. during the day and 75° at night. A vigorous population of mites, obtained originally from a culture of carmine spider mites known as the Beltsville colony, was maintained on lima bean plants.

Each tomato plant was infested by placing two adult female mites on each of two apical leaflets, whose rachis had been banded with lanolin. The mites were allowed to remain on the leaves for 72 hours, at which time the eggs laid were counted using a stereoscopic microscope.

[1] Formerly *T. telarius* (Linnaeus).

[2] Stoner, A. K., and Stringfellow, T. resistance of tomato varieties to spider mites. Amer. Soc. Hort. Sci. Proc. 90: 324–329. 1967.

[3] Gilbert, J. C., Chinn, J. T., and Tananka, J. S. spider mite tolerance in multiple disease resistant tomatoes. Amer. Soc. Hort. Sci. Proc. 89: 559–562. 1966.

[4] Wolfenbarger, D. A. tomato, lycopersicon esculentum, and lycopersicon species and genetic markers in relation to mite, tetranychus marianae, infestations. Jour. Econ. Ent. 58: 891–893. 1965.

[5] Boodley, J. W., and Sheldrake, R., Jr. artificial soils for commercial plant growing. Cornell Ext. Bul. 1104, 8 pp. 1963.

Because of the number of lines involved, it was necessary to run the tests for 9 weeks. For a comparative evaluation of the results from each test, 10 plants each of the varieties Kalohi and KC146 were added as checks to each group of material to be evaluated. Kalohi was chosen as the resistant check and KC146 was the susceptible check, based on the report of Stoner and Stringfellow.[2] To compare directly 1 week's results with another, the average number of eggs laid per mite on each line was adjusted by the average amount that the Kalohi plants for that week differed from the average performance of Kalohi for the 9 weeks.

RESULTS AND DISCUSSION

The results of the screening tests are given in table 1. The accessions tested are grouped according to species, varieties, and forms as was indicated by the U.S. Plant Introduction stations on the seed envelopes. For each accession tested, the average number of eggs laid per live mite is given. Also in table 1 is indicated the percentage of the original mites placed on the leaves that were live, dead, or missing at the time of the egg count.

[2] Stoner, A. K., and Stringfellow, T. resistance of tomato varieties to spider mites. Amer. Soc. Hort. Sci. Proc. 90: 324–329. 1967.

Table 1.—*Resistance of wild and cultivated* Lycopersicon *species to carmine spider mite, based on its oviposition rate and condition after 72 hours on plant leaves*

Lycopersicon species and P.I. accession No.	Average eggs per live mite	Condition of mites		
		Live	Dead	Missing
L. esculentum	*Number*	*Percent*	*Percent*	*Percent*
Kalohi (check)	5.2	43	31	26
KC146 (check)	11.1	52	14	34
109513	10.2	55	20	25
109831	3.2	50	19	31
109832	7.8	30	25	45
109833	7.6	40	40	20
109838	13.6	25	44	31
117900	12.6	50	36	14
118408	14.0	55	10	35
119778	8.8	30	45	25
120256	7.0	35	10	55
120258	6.5	45	25	30
121437	6.0	55	25	20
124036	7.5	55	10	35
127820	13.3	55	20	25
128246	6.3	30	15	55
129052	8.0	50	31	19
131878	10.9	35	40	25
131881	13.1	35	10	55
135844	9.4	62	10	28
135907	5.2	50	6	44
136450	9.8	38	12	50
140404	8.9	50	0	50
140410	13.4	55	10	35

TABLE 1.—*Resistance of wild and cultivated* Lycopersicon *species to carmine spider mite, based on its oviposition rate and condition after 72 hours on plant leaves*—Continued

Lycopersicon species and P.I. accession No.	Average eggs per live mite	Condition of mites		
		Live	Dead	Missing
	Number	*Percent*	*Percent*	*Percent*
140412	4. 6	50	0	50
142700	4. 4	45	36	19
146090	8. 6	44	31	25
148720	10. 3	70	20	10
167099	4. 8	40	40	20
167103	4. 8	55	5	40
169578	4. 4	40	35	25
174264	6. 1	30	35	35
174266	4. 3	35	30	35
174269	7. 8	20	50	30
175774	7. 7	33	24	43
175775	6. 2	45	23	32
177458	8. 2	33	43	24
182230	5. 9	50	10	40
183692	2. 4	30	65	5
188566	8. 2	25	45	30
193399	16. 5	55	30	15
193403	9. 5	60	25	15
194308	9. 2	40	10	50
194884	10. 5	30	20	50
196297	12. 0	62	5	33
199016	6. 1	40	15	45
199018	11. 9	50	10	40
201476	5. 0	50	0	50
203229	5. 1	40	30	30
204977	10. 6	25	17	58
206151	1. 7	35	5	60
212018	8. 7	20	30	50
212412	7. 7	40	15	45
213188	6. 3	60	15	25
213189	9. 1	40	25	35
220865	10. 7	67	0	33
223306	8. 2	65	5	30
223308	8. 8	43	19	38
223310	7. 3	55	20	25
223311	7. 2	45	15	40
223312	3. 2	15	60	25
223315	7. 8	65	15	20
223316	2. 0	40	45	15
234625	5. 4	33	12	55
237132	10. 3	60	10	30
237133	7. 5	76	14	10
237137	9. 2	60	0	40
247089	4. 7	36	16	48
247528	9. 6	60	5	35
250432	7. 4	45	25	30
250433	5. 6	40	35	25
250435	10. 0	75	5	20
255829	10. 9	50	25	25
255839	9. 1	50	6	44
255847	4. 0	50	0	50
255848	7. 3	70	15	15
255849	11. 3	35	10	55
255855	7. 2	50	0	50

TABLE 1.—*Resistance of wild and cultivated* Lycopersicon *species to carmine spider mite, based on its oviposition rate and condition after 72 hours on plant leaves*—Continued

Lycopersicon species and P.I. accession No.	Average eggs per live mite	Condition of mites		
		Live	Dead	Missing
	Number	*Percent*	*Percent*	*Percent*
255856	10.6	20	20	60
255862	8.1	40	20	40
255867	8.5	55	10	35
255868	11.6	71	5	24
255955	16.5	65	5	30
257290	9.0	60	10	30
257503	8.8	55	15	30
260395	9.0	38	29	33
260396	13.0	65	5	30
260399	7.9	52	19	29
262159	12.8	55	10	35
262160	7.8	50	14	36
262162	4.8	40	30	30
262173	6.9	60	10	30
262174	11.0	40	15	45
262175	11.9	60	0	40
262929	9.2	65	5	30
262934	6.6	60	20	20
262938	6.4	55	20	25
262940	8.5	45	30	25
262999	5.5	65	10	25
263000	6.1	70	10	20
263710	6.1	50	5	45
263711	9.8	71	10	19
263712	10.8	65	5	30
263713	8.3	30	15	55
263717	11.3	40	30	30
263719	7.7	76	5	19
263725	3.1	25	40	35
264336	4.7	40	15	45
264548	8.5	31	13	56
269141	8.0	60	15	25
269142	10.7	55	20	25
270217	11.6	50	5	45
270236	9.0	67	5	28
270254	12.4	67	23	10
271381	6.4	40	20	40
271384	15.3	15	15	70
271386	7.4	35	30	35
271482	7.1	45	25	30
272219	7.3	35	55	10
273444	6.5	45	30	25
273447	6.8	20	25	55
275014	8.1	50	25	25
275015	9.3	40	20	40
275016	7.4	45	15	40
276424	6.4	30	30	40
280060	9.9	40	15	45
285132	4.5	50	35	15
285133	2.0	50	25	25
288069	4.9	40	25	35
288070	6.7	55	5	40
302462	8.0	40	25	35
302463	8.1	45	20	35

TABLE 1.—*Resistance of wild and cultivated* Lycopersicon *species to carmine spider mite, based on its oviposition rate and condition after 72 hours on plant leaves*—Continued

Lycopersicon species and P.I. accession No.	Average eggs per live mite	Condition of mites		
		Live	Dead	Missing
	Number	*Percent*	*Percent*	*Percent*
302464	4. 9	35	25	40
304062	7. 8	40	15	45
304234	2. 9	10	25	65
304236	11. 4	50	10	40
304398	10. 2	50	35	15
309915	5. 2	40	20	40
321040	7. 5	45	15	40
321041	8. 2	45	0	55
321042	9. 7	15	15	70
321043	5. 8	48	9	43
321044	5. 3	50	6	44
321045	3. 4	35	20	45
321046	6. 9	60	15	25
321047	5. 3	55	5	40
321048	8. 4	55	0	45
321049	2. 8	25	5	70
321050	7. 6	65	5	30
321051	8. 1	39	0	61
321052	5. 4	55	5	40
321053	7. 3	45	10	45
321054	7. 6	50	17	33
321055	5. 5	60	15	25
321056	5. 5	40	25	35
321058	7. 9	60	5	35
321059	9. 1	55	10	35
321060	6. 9	62	10	28
321061	3. 1	20	25	55
321062	6. 1	30	40	30
321063	6. 4	60	10	30
321064	9. 6	60	0	40
321065	8. 4	48	19	33
321066	6. 5	35	15	50
321067	10. 2	71	6	23
321068	7. 4	48	14	38
321069	6. 8	45	5	50
321070	8. 8	28	5	67
321071	8. 6	30	0	70
L. esculentum var. *cerasiforme*				
117565	7. 0	55	27	18
197159	6. 1	30	25	45
270433	1. 6	50	20	30
L. pimpinellifolium				
126436	14. 2	45	10	45
126924	17. 1	50	5	45
126931	15. 8	60	5	35
L. hirsutum				
126445 [1]	2. 5	35	60	5
	7. 5	19	81	0
	1. 8	35	61	4

See footnote at end of table.

TABLE 1.—*Resistance of wild and cultivated* Lycopersicon *species to carmine spider mite, based on its oviposition rate and condition after 72 hours on plant leaves*—Continued

Lycopersicon species and P.I. accession No.	Average eggs per live mite	Condition of mites		
		Live	Dead	Missing
	Number	*Percent*	*Percent*	*Percent*
127826 [1]	3.4	25	75	0
	8.0	35	55	10
	5.6	27	53	20
127827	3.6	28	55	17
L. hirsutum f. *glabratum*				
126449 [1]	3.5	40	30	30
	13.5	20	25	55
	1.7	44	38	18
129157	2.8	30	35	35
134417	6.0	15	55	30
134418	10.6	70	15	15
199381	4.9	50	45	5
251304	1.8	20	60	20
L. glandulosum				
126434	14.6	90	0	10
126440	16.6	75	0	25
126443	14.1	48	4	48
126444	18.1	86	0	14
126448	17.5	85	0	15
199380	16.1	70	5	25
251302	14.0	75	0	25
L. peruvianum				
126441	16.2	52	0	48
126926	18.8	75	0	25
126928	15.8	71	10	19
126929	14.7	74	0	26
126944	13.9	25	10	65
126945	16.9	67	0	33
126946	14.5	70	5	25
128646	16.9	63	11	26
128647	17.1	55	0	45
128648	17.2	40	10	50
128649	15.2	91	0	9
128656	15.5	63	4	33
128657	16.0	57	5	38
128659	15.5	55	5	40
128660	16.4	54	0	46
128661	15.3	55	5	40
128663	13.5	55	0	45
129145	15.6	57	10	33
129149	16.3	50	0	50
129152	16.7	63	12	25
270435	15.7	80	0	20
L. peruvianum var. *dentatum*				
126431	9.9	50	15	35
127830	19.6	70	15	15
128643	16.0	55	5	40

See footnote at end of table.

TABLE 1.—*Resistance of wild and cultivated* Lycopersicon *species to carmine spider mite, based on its oviposition rate and condition after 72 hours on plant leaves*—Continued

Lycopersicon species and P.I. accession No.	Average eggs per live mite	Condition of mites		
		Live	Dead	Missing
	Number	*Percent*	*Percent*	*Percent*
128645	17.8	60	10	30
128650	12.0	45	10	45
128653	21.6	35	15	50
128654	15.4	55	5	40
128655	21.2	45	10	45
129146	16.0	55	5	40
251306	11.7	35	15	50

[1] Screened 3 times.

Of the 220 accessions tested, 36 indicated resistance equal to or better than Kalohi. An additional 19 accessions averaged up to one egg more per live mite than Kalohi and may also be valuable as sources of resistance. The accessions that performed equal to or better than Kalohi are distributed by species as follows: 28 *L. esculentum* Mill., one *L. esculentum* var. *cerasiforme* (Dun.) A. Gray, three *L. hirsutum* Humb. and Bonpl., and four *L. hirsutum* f. *glabratum* C. H. Mull. The accession numbers and data for these 36 lines are given in table 2.

The highest resistance appears to be in the *L. hirsutum* species and its form *glabratum*. According to Muller,[6] these two are very similar and grade into one another. Eight of the nine *L. hirsutum* accessions tested had high resistance. Three of them tested a second time had higher susceptibility than Kalohi. However, a third evaluation supported the ratings of the first screening. In the third test five mites were placed on each leaf instead of two.

The low resistance in the second evaluation of the three *L. hirsutum* accessions can be ascribed to individual susceptible plants in these lines. In all three instances one or two plants were highly susceptible and these markedly raised the average number of eggs per mite. Likewise, the 5.6 rating given to P.I. 127826 in the final screening can be attributed to one plant that had three live mites and 53 eggs. This variation within the lines is to be expected, because they have probably never been subjected to natural selection for mite resistance. Also, since P.I. 126445 and P.I. 127826 are self-incompatible, they probably would be rather variable.

Resistance is revealed by increased mortality as well as by reduced oviposition. The ratings shown for the second screening of the *L. hirsutum* accessions are based on only four, seven, and four live mites of the original 20 placed on each accession. Since spider mites feed before or during oviposition, a toxic material in the leaf tissue may kill some mites in 72 hours. Those not killed during the test period

[6] MULLER, C. H. A REVISION OF THE GENUS LYCOPERSICON. U.S. Dept. Agr. Misc. Pub. 382, 29 pp. 1940.

TABLE 2.—*36 accessions of* Lycopersicon *species with resistance equal to or greater than Kalohi to carmine spider mite, based on its oviposition rate and condition after 72 hours on plant leaves*

Lycopersicon species and P.I. accession No.	Average eggs per live mite	Condition of mites		
		Live	Dead	Missing
L. esculentum	*Number*	*Percent*	*Percent*	*Percent*
Kalohi (check)	5. 2	43	31	26
206151	1. 7	35	5	60
223316	2. 0	40	45	15
285133	2. 0	50	25	25
183692	2. 4	30	65	5
321049	2. 8	25	5	70
304234	2. 9	10	25	65
263725	3. 1	25	40	35
321061	3. 1	20	25	55
109831	3. 2	50	19	31
223312	3. 2	15	60	25
321045	3. 4	35	20	45
255847	4. 0	50	0	50
174266	4. 3	35	30	35
142700	4. 4	45	36	19
169578	4. 4	40	35	25
285132	4. 5	50	35	15
140412	4. 6	50	0	50
247089	4. 7	36	16	48
264336	4. 7	40	15	45
167099	4. 8	40	40	20
167103	4. 8	55	5	40
262162	4. 8	40	30	30
288069	4. 9	40	25	35
302464	4. 9	35	25	40
201476	5. 0	50	0	50
203229	5. 1	40	30	30
135907	5. 2	50	6	44
309915	5. 2	40	20	40
L. esculentum var. *cerasiforme*				
270433	1. 6	50	20	30
L. hirsutum				
126445 [1]	2. 5	35	60	5
	7. 5	19	81	0
	1. 8	35	61	4
127826 [1]	3. 4	25	75	0
	8. 0	35	55	10
	5. 6	27	53	20
127827	3. 6	28	55	17
L. hirsutum f. *glabratum*				
126449 [1]	3. 5	40	30	30
	13. 5	20	25	55
	1. 7	44	38	18
129157	2. 8	30	35	35
199381	4. 9	50	45	5
251304	1. 8	20	60	20

[1] Screened 3 times.

could be sufficiently affected to have reduced reproduction. Several mites listed as alive in table 1 were actually moribund and apparently had been inactive for some time. This is especially true of those on the *L. hirsutum* accessions.

Perhaps more noteworthy than the resistance found in *L. hirsutum* is the resistance present in *L. esculentum*. Of the 167 *L. esculentum* accessions tested, 28 of them, or 17 percent, were more resistant than Kalohi. Many of the 28 received a resistance rating comparable to that of the *L. hirsutum* accessions. However, a higher percentage of the mites were alive and apparently healthy on the *L. esculentum* than on the *L. hirsutum* plants. For a practical breeding program, it would be relatively simple to utilize the resistance inherent in the *L. esculentum* species as compared with that in *L. hirsutum.*

The intraline segregation for resistance previously discussed for *L. hirsutum* was also observed in *L. esculentum*, although only five plants of each line were tested. To take advantage of the variation within lines, seed was saved from several individual plants that appeared to have high mite resistance.

The variety KC146, included in each group of material screened, was used as the susceptible check, because it had been one of the most susceptible of the commercially adapted varieties. Of the accessions screened, 60 proved to be more susceptible than KC146. These included 20 *L. esculentum* Mill., all three *L. pimpinellifolium* (Jusl. in L.) Mill., all seven *L. glandulosum* C. H. Mull., all 21 *L. peruvianum* (L.) Mill., and nine *L. peruvianum* var. *dentatum* Dun.

It can be concluded that much variation in susceptibility to the carmine spider mite exists in the *Lycopersicon* species. The screening tests indicated that *L. hirsutum* possesses the highest resistance of any species closely related to the cultivated tomato. Although only nine *L. hirsutum* lines were tested, seven exhibited higher resistance than the *L. esculentum* variety Kalohi used as a resistant check. Since considerable resistance also exists in some of the *L. esculentum* accessions, an interspecific transfer of genes is not necessary for developing resistant breeding lines.

Of the *L. pimpinellifolium*, *L. glandulosum*, and *L. peruvianum* lines tested, all proved extremely susceptible and were more so than KC146, the susceptible check.

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